

Of the 127,360 acres of selectable land about 50,000 is already occupied by selectors, under the provisions of the Land Act 1869, and about 9000 purchased, leaving a balance available of 68,000 acres.

I regret that the limited time allowed for the reading of this paper has prevented me giving a more detailed description of the area. I trust, however, that the facts noticed may lead to a better knowledge of this portion of the Victorian Cordillera, and I hope shortly to prepare a paper, dealing not only with the geological structure of the area, but its characteristic native vegetation.

ART. XIX.—*On a New Form of Secondary Cell for
Electrical Storage.*

BY H. SUTTON.

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THE great utility of some thoroughly practical method of conserving electric force has caused a great deal of attention to be applied to the subject. No system of electric supply can be considered perfect until some means is used to so store the force generated that it may be drawn off equally and regularly, and this whether the generator be on or off.

If we take as an example of electric supply the present systems of electric lighting, it is at once seen, should an accident or stoppage take place in the machinery generating the current, the whole of the apparatus, such as lamps or motive machines, would be influenced. Should there be a reservoir of electricity between the generator and the apparatus for utilising the force, this inconvenience could not occur, as the reservoir would then supply the necessary force.

All the present systems of storing electricity depend on certain chemical changes produced by electrolysis; the first effective apparatus being that discovered by M.

Plante, and which consisted of two sheets of lead immersed in dilute sulphuric acid. When these plates are made the positive and negative electrodes of a few voltaic cells or other source of electricity of sufficient power, the oxygen of the decomposed solution combines with the positive electrode, and forms a coat of the insoluble peroxide of lead. On disconnecting the charging source, the plates have the power of generating a powerful current of electricity, owing to the great affinity the oxygen of the peroxide has for the hydrogen of the solution when the circuit is closed.

A recent form of this cell has been devised by M. Faure, in which the lead plates have a coat of red oxide of lead painted on, the chemical change in this case being—the red oxide on the positive electrode on charging becomes exalted to the state of peroxide, whilst the hydrogen combines with the oxygen of the negative red oxide coating and reducing metallic lead; the chemical change of discharge being precisely the same as in Plante's cell.

This red oxide cell has caused a great stir in the electrical world, owing to some exaggerated reports having gone through the press.

Although there is a great deal that is pernicious in exaggerated press reports, they have one virtue, and that is, the incentive they give to workers to improve, or, if possible, discover new means of producing the same results. This was shown in the invention of the telephone; and the same will occur in connection with electrical storage.

These reports reminded me of an experiment I made some time previously on the behaviour of peroxide of lead as an element in voltaic cells. I prepared some peroxide by treating red oxide of lead with dilute hydric nitrate till the brown precipitate of peroxide fell; collected the precipitate, and made a conglomerate of it, and using it as an element in a small voltaic cell.

I have since then gone through a long series of experiments in storing electricity, and made many different forms of cell; one being a porous pot containing dilute hydric sulphate and a sheet of lead, and an outer containing vessel, having a sheet of lead immersed in a solution of acetate of lead, the plate in the porous pot being made the positive electrode. This cell had the power of storing electricity, by peroxidising the positive electrode and depositing metallic lead from the solution on the negative electrode, the acetate being then converted into a solution of acetic acid. On discharging the

peroxide is reduced and the apposed element oxydised, the oxide formed combining with the acetic acid; and forming acetate of lead.

During my experiments I found that the red oxide of lead is a bad conductor of electricity; that peroxide of lead is a good conductor; and that by amalgamating lead plates with mercury a marked increase was immediately manifest in polarisation effects, the plates being more uniformly and rapidly peroxidised, and local action entirely disappearing. These mercury amalgamated plates at once gave me an advance over other cells.

I used them in many ways, constructing cells in which the positive electrode was amalgamated lead, the negative being coated with prepared peroxide or with the red oxide, or amalgamated, or combinations of these and solutions of various kinds.

I also made cells of peroxide, and also of red oxide, formed into porous conglomerites, having a wire projecting from each end, the conglomerite being immersed in dilute hydric sulphate. I constructed cells in which the plates were parallel, and the red oxide, as also the peroxide, being filled in between the plates. In this case the red oxide is useless and peroxide efficient, owing to their relative conducting power. In all cases in which amalgamated lead was used as a positive electrode the effects were very marked.

Having thoroughly tested the amalgamated lead, and found it the most efficient positive electrode for conserving the oxygen of the decomposed solution, I investigated the behaviour of various forms of negative electrode, having always the object in view, of making the hydrogen of the decomposed solution do some work; the proper thing, of course, being to make it assist in depositing metal from the solution on the negative electrode.

I thought by having negative electrodes, whose oxides should be soluble in the solution remaining after electrolysis, and which could be redeposited from the solution, or by having metallic solutions from which the metal could be deposited—the resulting solution being such that on the oxidation of the deposited metal it would combine with the oxide, and again form the original solution—I should produce a perfect means of storing electric energy by conversion into chemical energy, and which would economically return the current as the chemical affinity ran down.

Having started from this foundation, the results obtained

are such as to have an important practical bearing on the future of electric work.

The experiments comprised lead amalgamated with mercury as a positive electrode, with negative electrodes composed of either zinc, iron, or copper; in each case the solution between the electrodes being a salt of the metal composing the negative electrode. With zinc a solution of zinc sulphate was used; with iron, sulphate of iron was the solution; and with copper, sulphate of copper.

In all these cases the results were not only far more powerful than any form of cell I had hitherto devised, but also remarkably constant.

The cell with zinc negative electrode I discarded, owing to the necessity there would be to keep the zinc plate amalgamated to prevent local action; the iron negative cell being set aside owing to the iron oxidising when not in use. In both the zinc and iron negative electrodes the evil effects only show when the cell is charged.

The cell having a negative electrode of copper is the one I have adopted as a thoroughly economical, lasting, and practical form of storage reservoir. The chemical changes in this cell are exceedingly interesting and beautiful.

The cell is composed of a sheet of lead cleaned with dilute sulphuric acid, and amalgamated thoroughly with mercury, and a sheet of thin copper, a little shorter; the two sheets are perforated with a number of holes. The copper is placed uppermost, and separated by bands of rubber, having pieces cut out every few inches, the whole being rolled into a spiral; the object of the holes in plates and pieces cut out of rubber being to allow the solution to have free access to the plates. This combination is immersed in a solution of cupric sulphate, and the amalgamated lead made the positive electrode of a suitable source of electricity. The chemical action being the oxygen of the decomposed solution, combines with the lead, and forms a coating of the insoluble peroxide of lead, the hydrogen replacing the copper in the solution, and metallic copper being deposited on the negative electrode. As decomposition of the solution proceeds it becomes colourless, and more acid, until, when the whole of the copper is deposited, we have the solution transformed into dilute sulphuric acid, the amalgamated lead peroxidised, and pure copper deposited on the negative electrode.

During discharge the peroxide of the lead element is

reduced, the copper element becoming oxidised; the oxide combines with the acid, and forms cupric sulphate, the solution returning to its original azure blue colour. This change in colour forms a beautiful means of knowing when the cell is fully charged. The power of this cell is very great and constant; it can be made to last for hours, the length of time being dependent on the quantity of cupric sulphate being decomposed in solution. I have, by the decomposition of one pint of solution cupric sulphate, obtained over two hours' effective work as electric energy.

It will be seen from the foregoing that this method of conserving energy has a wide field before it.

NOTE 1.—The amalgamated lead electrode will not peroxidise if free cupric sulphate crystals are present in the solution, it being essential that the solution become acid.

NOTE 2.—The charging is accompanied with a peculiar rattling noise, and is not due to escaping gas, as the noise occurs when no gas escapes from the solution, but may be due to change of form in spiral due to deposition of copper.

ADDENDUM.

THE secondary, in its present form, consists of a flat copper case, having the form of the outer containing vessel of a Grove's cell. In this copper cell is a sheet of lead amalgamated with mercury, and which has a piece of flannel, or other porous material, enveloping it tightly, the object of which is to prevent the peroxide (which forms a thick layer) from falling off by the wash of the solution, or by jarring. I have removed as much as six ounces of peroxide, which has been formed in a single charge in one of my cells.

The amalgamated plate is supported in middle of copper cell by being held in a groove in a piece of paraffined wood lying at the bottom of copper cell, and also by a paraffined wood cap, which closes the top; it is charged with a solution of cupric sulphate, containing one-twelfth of hydric sulphate.

The amalgamated lead is made the positive electrode, and the copper case the negative, the inner surface of the copper case receiving the deposited copper when charging with electricity. The electromotive force of the cell is about two volts.